ESTIMATED COSTS FOR AMINE STILL VENT CO_2 EMISSIONS GHG PSD AIR PERMIT APPLICATION TO EPA
TRANSPORTATION AND GEOLOGIC SEQUESTRATION COSTS
65% CASE

Pipeline Length (L)[1]	20	miles
Pipeline Diameter (D)[2]	8	inches
Number of Injection Wells	27	
Depth of well	3,665	feet
	1117	meters
Tons CO_2 per day	586	tons
Metric Tons CO_2 per year	194,194	tonnes

Note: Annual Rate is too low to qualify for IRS Section 45Q tax credit

CCS Transportation Cost Breakdown

Cost Type	Units	Cost	2007	2014
Pipeline Costs[3]				
Pipeline Materials	$ Diameter (inches), Length (miles)	$64,632 + $1.85 x L x (330.5 x D^2 + 686.7 x D + 26,920)	$ 2,046,559.20	$ 2,341,103.97
Pipeline Labor	$ Diameter (inches), Length (miles)	$341,627 + $1.85 x L x (343.2 x D^2 + 2,074 x D + 170,013)	$ 8,058,709.60	$ 9,218,534.73
Pipeline Miscellaneous	$ Diameter (inches), Length (miles)	$150,166 + $1.58 x L x (8,417 x D + 7,234)	$ 2,506,578.00	$ 2,867,329.57
Pipeline Right of Way	$ Diameter (inches), Length (miles)	$48,037 + $1.20 x L x (577 x D +29,788)	$ 873,733.00	$ 999,482.35
Other Capital			SUBTOTAL	$ 15,426,450.62
Treatment and compression equipment[4]	$	Per Preliminary Design Estimate	$ 27,973,936.72	$ 32,000,000.00
O&M[2]			SUBTOTAL	$ 32,000,000.00
Fixed O&M	$/mile/year	2007= $8,632 Adjusted per DOT 2014	$ 172,640.00	$ 256,732.69
Estimated O&M for treatment facility[5]	$/year	2014 = $951,754 Adjusted per DOT 2014	$ 832,009.35	$ 951,753.75
			SUBTOTAL	$ 1,208,486.44

Amoritized CCS Cost

Total Capital Investment (TCI) =			$ 41,459,516.52	$ 47,426,450.62
Capital recovery factor (CRF)[1] = $i(1+i)^n/((1+i)^n - 1)$			0.15	0.15
i = interest rate =	0.08			
n = equipment life =	10	Years		
		Amortized installation costs = CRF * TCI =	$ 6,218,927.48	$ 7,067,939.69
		Total CCS Transportation Annualized Cost	**$ 7,223,576.83**	**$ 8,276,426.13**

1 Distance to pipeline is calculated based on approximate location of the Elmar Field.
2 "Estimating Carbon Dioxide Transport and Storage Costs," National Energy Technology Laboratory, U.S. DOE, DOE/NETL - 2010/1447, March 2010

3 Cost adjusted using average consumer price index to June 2014 dollars from June 2007 dollars based on data presented in Estimating Carbon Dioxide Transport and Storage Costs," National Energy Technology Laboratory, U.S. DOE, DOE/NETL - 2010/1447, March 2010.

4 Capital costs of treatment and compression equipment are estimated in 2014 dollars based on cost estimates communicated by Kinder Morgan for the planned facility that will treat and compress 35% of the Ramsey Amine Unit Still Vent CO_2 stream.

5 Treatment facility operating and maintenance costs estimated based on similar proposed facility

NOTE: This cost estimate does not include: Costs for insurance or other CO_2 pipeline liability, short-term or geologic formation storage of CO_2

CCS Sequestration Cost Breakdown

Cost Type	Units	Cost		
Captial Costs[3]			2007	2014
Site Screening and Evaluation	$	$4,738,488	$ 4,738,488.00	$ 5,420,460.39
Site Permitting	$			$ 150,000.00
Injection Wells	$/injection well	$240,714 x e $^{0.0008 \times \text{well-depth}}$	$ 15,884,832.03	$ 18,171,007.90
Injection Equipment	$/injection well	$94,029 x (7,389 / (280 x # of injection wells)) ^0.5	$ 92,959.49	$ 106,338.41
Liability Bond	$	$5,000,000	$ 5,000,000.00	$ 5,000,000.00
Declining Capital Funds			SUBTOTAL	$ 28,847,806.69
Pore Space Acquisition	$/short ton CO2	$0.334/short ton CO_2	$ 714,392.60	$ 817,209.37
O&M[2]			SUBTOTAL	$ 817,209.37
Normal Daily Expenses (Fixed O&M)	$/injection well	2007 = $11,566 per well Adjusted per DOT 2014	$ 312,282.00	$ 464,394.10
Consumables (Variable O&M)	$/yr/short ton CO2/day	2007 = $2,995 Adjusted per DOT 2014	$ 1,755,070.00	$ 2,609,962.01
Surface Maintenance (Fixed O&M)	see formula	$23,478 x (7,389 / (280 x # of injection wells)) ^0.5	$ 23,210.96	$ 34,516.98
Subsurface Maintenance (Fixed O&M)	$/ft-depth/inject.well	2007 = $ 7.08 Adjusted per DOT 2014	$ 700,601.40	$ 1,041,863.31
Class VI Area of Review Monitoring[4]	$	2008 = $51,724 Adjusted per DOT 2014	$ 51,724.14	$ 74,437.01
Class VI Well Monitoring[4]	$	2008 = $758,621 Adjusted per DOT 2014	$ 758,620.69	$ 1,091,742.85
			SUBTOTAL	$ 5,316,916.25

Amoritized CCS Cost

Total Capital Investment (TCI) =			$ 26,430,672.13	$ 29,665,016.06
Capital recovery factor (CRF)[1] = $i(1+i)^n/((1+i)^n - 1)$			0.15	0.15
i = interest rate =	0.08			
n = equipment life =	10	Years		
		Amortized installation costs = CRF * TCI =	$ 3,964,600.82	$ 4,420,962.18
		Total CCS Sequestration Annualized Cost	**$ 7,566,110.00**	**$ 9,737,878.43**

2 "Estimating Carbon Dioxide Transport and Storage Costs," National Energy Technology Laboratory, U.S. DOE, DOE/NETL - 2010/1447, March 2010

3 Cost adjusted using average consumer price index to June 2014 dollars from June 2007 dollars based on data presented in Estimating Carbon Dioxide

4 Average of annual costs of required monitoring for 29 project discussed in the Class VI well rule as documented in FR 75, 77279. 2008 dollars adjusted to 2014 as described above.

NOTE: This cost estimate does not include: State or locally required permitting or monitoring costs.

Grand Total CCS Sequestration Annualized	**$14,789,686.83**	**$ 18,014,304.56**
Cost per ton removed annually		**$ 84.22**
Total First Year of Operation Cost		**$ 83,616,869.39**

Amoritized Project Cost (without CCS)

Total Capital Investment (TCI) =			$ 300,000,000.00
Capital recovery factor (CRF) 1 = i(1+i)n/((1+i)n - 1)			0.10
i = interest rate =	0.08		
n = equipment life =	20	years	
		Amortized installation costs = CRF * TCI =	$ 30,555,662.65
		Total Project Annualized Cost	**$30,555,662.65**

NOTE: Plant lifetime estimated at 20 years, due to normal plant lifetime expectations. However, CCS equipment life anticipated to be 10 years based upon extreme acidic conditions of CO_2 stream.

Annualized Cost of CCS as percent of Project Cost **59%**